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Two Spin Liquid phases in the anisotropic triangular Heisenberg model

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Recently there have been rather clean experimental realizations of the quantum spin 1/2 Heisenberg Hamiltonian on a 2D triangular lattice geometry in systems like Cs_2CuCl_4 and organic compounds like $k-(ET)_2Cu_2(CN)_3$. These materials are nearly two dimensional and are characterized by an anisotropic antiferromagnetic superexchange. The strength of the spatial anisotropy can increase quantum fluctuations and can destabilize the magnetically ordered state leading to non conventional spin liquid phases. In order to understand these interesting phenomena we have studied, by Quantum Monte Carlo methods, the triangular lattice Heisenberg model as a function of the strength of this anisotropy, represented by the ratio r between the intra-chain nearest neighbor coupling J' and the inter-chain one J. We have found evidence of two spin liquid regions, well represented by projected BCS wave functions[1,2] of the type proposed by P. W. Anderson at the early stages of High temperature superconductivity [3]. The first spin liquid phase is stable for small values of the coupling $r \lesssim 0.6$ and appears gapless and fractionalized, whereas the second one is a more conventional spin liquid, very similar to the one realized in the quantum dimer model in the triangular lattice[4]. It is characterized by a spin gap and a finite correlation length, and appears energetically favored in the region $0.6 \lesssim r \lesssim 0.9$. The various phases are in good agreement with the experimental findings and supports the existence of spin liquid phases in 2D quantum spin-half systems.

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